REMARKS

Claims 1-3, 9 and 12-14 were rejected under 35 USC 103 over Hayashi in view of Solayappan and claims 4-8, 10 and 11 over the same combination in further view of Ogi. Both of these rejections are respectfully traversed.

In its broadest aspect, the present invention relates to a method of producing a complex oxide thin-film on a substrate by providing a solution containing at least two metal compounds dissolved in a solvent, atomizing the solution in a two-fluid nozzle and directly introducing the atomized solution into a substrate-containing film-forming chamber which is being maintained at a pressure of about 100 Torr or lower, and forming the complex oxide thin-film on the substrate in the chamber at a temperature of a least the boiling point of the solvent. The resulting complex oxide thin-film which has been formed can be dried by heat treating as set forth, for example, in pending claim 7. This process is neither taught nor suggested by the references.

The Hayashi patent relates to a misted precursor deposition apparatus and method of its use. The process involves obtaining a liquid precursor which is misted inside the apparatus to provide a colloidal mist which, after being filtered, is flowed into a deposition chamber to deposit a liquid layer on the substrate. The liquid layer can thereafter be dried to form a thin-film of solid material on the substrate. The purpose of the drying in the reference is to remove volatile organic moieties from the thin film of solution on the substrate (column 8, lines 37-38), which is the same reason that the film is heat treated as specified in claim 7 of the present application (see page 20, lines 6-10). It will thus be appreciated that the forming step (c) of the present claims refers to causing the complex oxide thin-film to be on the substrate and unto the rules of claim differentiation, is distinct from the drying of claim 7.

Further, as pointed out on the bottom of page 18 of this application, by directly introducing the atomized solution into the film-forming chamber from the two-fluid

nozzle, the atomized solution does not need to be carried by a piping or similar apparatus. Hayashi's process, on the other hand, generates the mist which is then allowed to settle in a buffer chamber and filtered before it is introduced into the deposition chamber.

In the claimed method, the formation of the complex thin-film oxide on the substrate takes place at a temperature which is at least equal to the boiling point of the solvent. Hayashi's deposition of the liquid on the substrate surface, in contrast, takes place at a temperature which is lower then the boiling point of the solvent. Hayashi specifically points out at column 7, line 66 to column 8, line 10 that the

> screened mist... is evenly flowed across and onto a substrate 5 at ambient temperature. Herein, ambient temperature means the temperature of the surroundings. That is, no additional heat, other than the heat from the surroundings, is applied to the substrate. When UV radiation is being applied, the temperature of the surroundings will be somewhat higher than room temperature, and when no UV radiation is being employed and a vacuum is being applied to treat the substrate, the ambient temperature can be somewhat less than room temperature. Based on the above, in general, ambient temperature may be between -50°C and 100°C.

Hayashi describes possible solvents at the bottom of column 6 and the lowest boiling point of these is 111°C, which is higher than Hayashi's "ambient temperature" of up to 100°C.

The Office Action avers that the Hayashi reference specifically teaches heating the "applied" precursor to 200-500°C and then 500-1,000°C to form the oxide film, citing column 8, lines 36-57. it is respectfully submitted that this assertion is incorrect in two aspects. First, lines 36-57 relate to drying and/or annealing steps which take place after the thin film has been formed on the substrate. Hayashi specifically so states at lines 37-38 and 54-56. See also column 14, lines 33-36 where Hayashi points out

that the baking and/or kneeling takes place on "a film... which has been previously deposited on a substrate. . . ." Secondly, the drying and annealing does not "form" the oxide film but rather removes volatile organic materials from the already formed oxide film on the substrate. The applicant also dry the formed film by heating but as stated in claim 7, do so under a pressure which is lower than that employed for the film forming. While Hayashi does indicate that the drying temperature can be reduced if a vacuum is drawn (column 8, lines 46-48), nowhere in the reference is the degree of such vacuum discussed. The Office Action is correct in indicating that this ambiguous teaching means that the pressure "can be less" than during deposition but it is just as accurate to say that it can be the same or more than during deposition. The issue under Section 103 is not whether the pressure can theoretically be less but whether it is obvious to make the pressure less. There is no basis in Hayashi for such a conclusion other than through the use of speculation or hindsight reconstruction, both of which are not permissible.

It will be appreciated from the foregoing that Hayashi does not teach, inter alia, directly introducing an atomized solution into a substrate-containing chamber maintained at a pressure of about 100 Torr or lower and causing the formation of the thin film on the substrate in the chamber at a temperature equal to or higher than the boiling point of the solvent. Likewise, Hayashi does not teach or suggest film-forming at least twice with each film-forming step being followed by heat treatment under a pressure lower than that employed for the film forming. Neither the Solayappan or Ogi reference have been cited to cure these deficiencies but instead they have been cited to cure other deficiencies which the Examiner has identified in Hayashi. They cannot, therefore, render the claimed invention obvious.

In light of all of the foregoing considerations, it is respectfully submitted that this application is now in condition to be allowed and the early issuance of a Notice of Allowance is respectfully solicited.

Respectfully submitted,

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Appendix A

1. A method of producing a complex oxide thin-film comprising the steps of:

(a) providing a metal compound solution comprising at least two metal compounds dissolved in a solvent;

(b) atomizing the metal compound solution in a two-fluid nozzle, and directly introducing the atomized solution into a film-forming chamber in which the pressure is about 100 Torr or lower and having a substrate therein, and

(c) forming a complex oxide thin-film on a substrate in the film-forming chamber at a temperature equal to or higher than the boiling point of the solvent.

2. A method of producing a complex oxide thin-film according to claim 1, wherein the solution is atomized in the two-fluid nozzle with an oxidative gas.

3. A method of producing a complex oxide thin-film according to claim 2, wherein the solvent has a boiling point of at least 100° C under ordinary pressure.

4. A method of producing a complex oxide thin-film according to claim 3, wherein at least one of the metal compounds is a dipivaloylmethanato complex.

5. A method of producing a complex oxide thin-film according to claim 4, wherein at least one of the metal compounds is an acetylacetonato complex.

6. A method of producing a complex oxide thin-film according to claim 5, wherein the solution contains three metal compounds and at least one of the metal compounds is a metal alkoxide.

7. A method of producing a complex oxide thin-film according to claim 6, wherein the film-forming (c) is performed at least two times, and after each film-forming, the film is heat-treated under a pressure lower than that employed for the film forming.

8. A method of producing a complex oxide thin-film according to claim 7, wherein at least the film obtained after the final-forming is heat treated at an oxygen gas partial pressure higher than an oxygen gas partial pressure existent during film-forming.

9. A method of producing a complex oxide thin-film according to claim 1, wherein the solvent has a boiling point of at least about 100° C under ordinary pressure.

10. A method of producing a complex oxide thin-film according to claim 1, wherein at least one of the metal compounds is a dipivaloylmethanato complex.

11. A method of producing a complex oxide thin-film according to claim 1, wherein at least one of the metal compounds is an acetylacetonato complex.

12. A method of producing a complex oxide thin-film according to claim 1, wherein at least one of the metal compounds is a metal alkoxide.

13. A method of producing a complex oxide thin-film according to claim 1, wherein the film-forming is performed at least two times, and after each film-forming, the film is heat-treated under a pressure lower than that employed for the film-forming.

14. A method of producing a complex oxide thin-film according to claim 1, wherein at least the film obtained by the final film-forming is heat treated at an oxygen gas partial pressure higher than an oxygen gas partial pressure existent during film-forming.